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First records of the glass frogs *Hyalinobatrachium cappellei* (van Lidth de Jeude, 1904) and *H. mondolfii* Señaris & Ayarzagüena, 2001 (Anura, Centrolenidae) in the state of Amapá, Brazil

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Abstract

Glass frogs (Centrolenidae) are widely distributed in the Neotropics. This study presents novel data on two centrolenid species of the genus *Hyalinobatrachium* Ruiz-Carranza & Lynch, 1991 collected during herpetofaunal surveys carried out in Brazilian Amazonia of the state of Amapá. Here we report the first record of *Hyalinobatrachium cappellei* (van Lidth de Jeude, 1904) and *H. mondolfii* Señaris & Ayarzagüena, 2001, extending the known distribution of *H. mondolfii* 264 km east and filing gaps in the distribution range of *H. cappellei* in eastern Amazonia.

Keywords

Amazonia, amphibians, geographic distribution, Guiana Shield.

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Introduction

Centrolenidae Taylor, 1951, the glass frogs, is a family of anurans with 155 currently recognized species arranged within 12 genera, whose species are known as glass frogs (Frost 2020). This anuran family is endemic to the Neotropics and has a wide geographic distribution, occurring from southern Mexico through Central America and into South America (Guayasamin et al. 2009; Cintra et al. 2013). Representatives of three glass frog genera occur in Brazil: *Hyalinobatrachium* Ruiz-Carranza & Lynch, 1991; *Teratohyla* Taylor, 1951; and *Vitreorana* Guayasamin, Castroviejo-Fisher, Trueb, Ayarzagüena, Rada & Vilà, 2009 (Segalla et al. 2019).

The genus *Hyalinobatrachium* contains 32 species distributed in Central America and Amazonia, of which six occur in Brazil (Segalla et al. 2019). *Hyalinobatrachium cappellei* (van Lidth de Jeude, 1904) is distributed in Brazil, Colombia, French Guiana, Guyana, Suriname and Venezuela (Lescure and Marty 2000; Rodrigues et al. 2010; Castroviejo-Fisher et al. 2011a; Noronha et al. 2012; Simões et al. 2012; Fouquet et al. 2015; Oliveira et al. 2015a; Blanc 2016; Thompson et al. 2018; Fouquet et al. 2019). *Hyalinobatrachium mondolfii* Señaris & Ayarzagüena, 2001 is distributed in Amazonia of Bolivia, Brazil, Colombia, French Guiana, Guyana, Peru, Suriname,

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and Venezuela (Señaris and Ayarzagüena 2001; Castroviejo-Fisher et al. 2011a; Fouquet et al. 2015). Herein, we provide new state records of *H. cappellei* and *H. mondolfii* in three localities of the Brazilian state of Amapá and an updated geographic distribution map for these species.

Methods

Specimens were recorded and collected during herpetofaunal surveys conducted between March 2018 and April 2019 in the Cancão Municipal Natural Park (municipality of Serra do Navio) and Iratapuru River Sustainable Development Reserve (municipality of Laranjal do Jari), both in the state of Amapá, Brazil. The sampled localities consisted of riparian forest, seasonal ponds and upland forest on small hills. The specimens were collected under the National System of Biodiversity Information (SISBIO) permit #48102-2, identified through diagnostic characteristics described by Castroviejo-Fisher et al. (2011a) and housed in the Herpetological Collection of the Federal University of Amapá (CECC), Macapá, Brazil. In order to update the geographic distribution of *H. cappellei* and *H. mondolfii*, geographical coordinates of additional occurrence through herpetological surveys were obtained using a GPS Kit for the iPhone, literature and speciesLink database (http://www.splink.org.br). The map was produced using Google Earth and QGIS software (QGIS Development Team 2018).

Results

Hyalinobatrachium cappellei (van Lidth de Jeude, 1904)

Figure 1A

New record. BRAZIL • 1 adult ♂, snout-vent length (SVL) = 20.6 mm; state of Amapá, municipality of Laranjal do Jari, Iratapuru River Sustainable Development Reserve; 00.535°S, 052.542°W; 133 m a.s.l.; 10 April 2019; Vinícius A.B.M. de Figueiredo leg.; found at approximately 19:00 h perched on the underside of a leaf in the marginal vegetation on top of a spawning, at 1.90 m above the ground; CECC 2965.

Identification. The following combination of morphological characteristics differentiates *H. cappellei* from the sympatric *H. iaspidiense* (Ayarzagüena, 1992) and other Amazonian *Hyalinobatrachium* species: snout truncated in dorsal and lateral views, dorsal coloration in

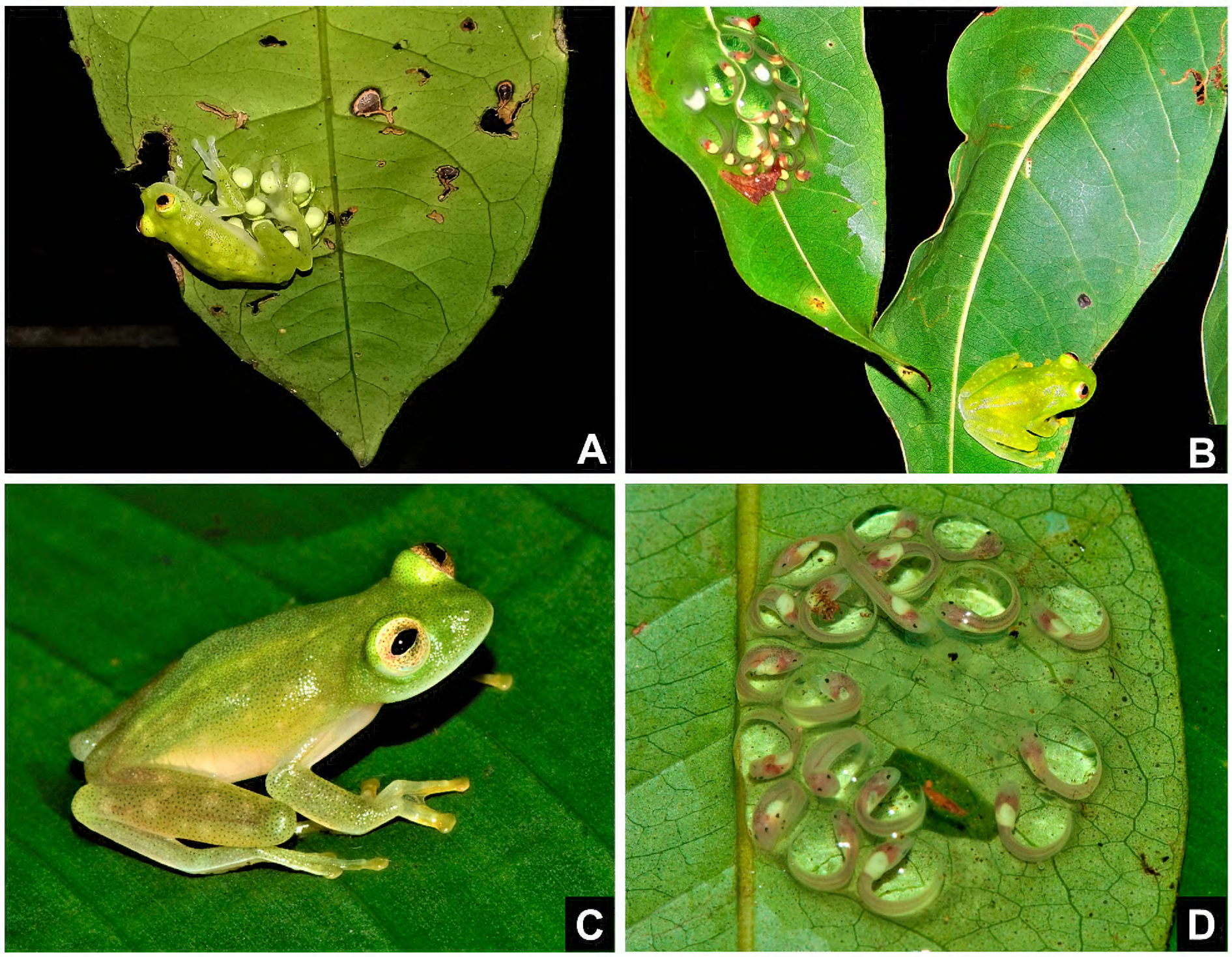

Figure 1. Males of two species of glass frogs and their spawning from two localities in the state of Amapá, Brazil. **A.** *Hyalinobatrachium cappellei* (CECC 2965; SVL = 20.6 mm). **B.** *Hyalinobatrachium mondolfii* (CECC 2783; SVL = 22.9 mm). **C.** *H. mondolfii* (CECC 1813; SVL = 22.0 mm). **D.** Egg clutch of *H. mondolfii* (CECC 1813).

Table 1. Localities, geographic coordinates, and new records of occurrence of the glass frogs *Hyalinobatrachium cappellei* and *H. mondolfii*. The asterisk (*) indicates the presence of both species in the same locality.

Locality	Country	Latitude	Longitude	Species	Reference
Amapá, Laranjal do Jari, Iratapuru River Sustainable Development Reserve	Brazil	−00.535°	−052.542°	*H. cappellei*	New record
Amazonas, Igapó-Açu	Brazil	−04.605°	−061.248°	*H. cappellei*	Simões et al. (2012)
Amazonas, Taquara	Brazil	−04.379°	−060.939°	*H. cappellei*	Simões et al. (2012)
Mato Grosso, Alta Floresta	Brazil	−10.055°	−056.366°	*H. cappellei*	speciesLink (2020)
Mato Grosso, Cotriguaçu	Brazil	−09.854°	−058.249°	*H. cappellei*	Noronha et al. (2012)
Mato Grosso, Juína	Brazil	−11.333°	−059.116°	*H. cappellei*	Noronha et al. (2012)
Mato Grosso, Juína	Brazil	−11.530°	−059.323°	*H. cappellei*	speciesLink (2020)
Mato Grosso, Novo Mundo	Brazil	−09.546°	−055.793°	*H. cappellei*	Noronha et al. (2012)
Pará, Altamira, Xingú River	Brazil	−03.516°	−051.666°	*H. cappellei*	Oliveira et al. (2015a)
Pará, Middle Tapajós River region	Brazil	−04.493°	−056.296°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.681°	−056.445°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.662°	−056.615°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.885°	−056.432°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.821°	−056.478°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.821°	−056.478°	*H. cappellei*	Moraes et al. (2016)
Pará, Middle Tapajós River region	Brazil	−04.821°	−056.478°	*H. cappellei*	Moraes et al. (2016)
Caquetá, Cartagena del Chairá	Colombia	00.252°	−074.305°	*H. cappellei*	Thompson et al. (2018)
Caquetá, Solano	Colombia	−00.001°	−074.644°	*H. cappellei*	Thompson et al. (2018)
Bassin de la Comté, Crique Trésor	French Guiana	04.583°	−052.300°	*H. cappellei*	Lescure and Marty (2000)
Bassin de la Sinnamary, Crique Grand Leblond	French Guiana	04.666°	−053.266°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bassin de la Sinnamary, Trinité	French Guiana	04.616°	−053.417°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bassin de l'Approuague, Saut Arataye	French Guiana	04.030°	−052.532°	*H. cappellei*	Lescure and Marty (2000)
Bassin de l'Oyapock, Montagne St Marcel	French Guiana	03.321°	−052.194°	*H. cappellei*	Lescure and Marty (2000)
Maripasoula, Haute Wanapi	French Guiana	02.684°	−053.814°	*H. cappellei*	Fouquet et al. (2019)
Maripasoula, Pic Coudreau du sud	French Guiana	02.702°	−053.278°	*H. cappellei*	Blanc (2016)
Montagne des Singes	French Guiana	05.083°	−052.633°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Kaw, Canal de Kaw	French Guiana	04.500°	−052.016°	*H. cappellei*	Lescure and Marty (2000)
Kaw, Crique Patawa	French Guiana	04.505°	−052.091°	*H. cappellei*	Lescure and Marty (2000)
Kaw, Crique Wapou	French Guiana	04.400°	−052.150°	*H. cappellei*	Lescure and Marty (2000)
Kaw, Kaw Mountain	French Guiana	04.533°	−052.216°	*H. cappellei*	Lescure and Marty (2000)
Kaw, Rivière de Kaw	French Guiana	04.609°	−052.056°	*H. cappellei*	Lescure and Marty (2000)
Cuyuni-Mazaruni, Pacaraima Mountains	Guyana	05.733°	−060.300°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Cuyuni-Mazaruni, Partang River	Guyana	05.805°	−060.215°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Potaro-Siparuni, Kaieteur	Guyana	05.166°	−059.483°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Amazonas, Cerro Yutajé	Venezuela	05.766°	−066.133°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Amazonas, Sierra de Tapirapecó	Venezuela	01.312°	−064.739°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Central Sector of Cerro Jaua	Venezuela	04.831°	−064.431°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Gran Sabana	Venezuela	05.666°	−061.616°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Guaiquinima	Venezuela	05.783°	−063.800°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Karuay river	Venezuela	05.690°	−061.861°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, San Ignacio de Yuraní	Venezuela	04.916°	−061.083°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Santa Elena road	Venezuela	05.959°	−061.396°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Serranía of Guanay	Venezuela	05.916°	−066.383°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Tepui	Venezuela	05.933°	−062.550°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Bolívar, Uruyen	Venezuela	05.685°	−062.525°	*H. cappellei*	Castroviejo-Fisher et al. (2011a)
Amapá, Laranjal do Jari, Iratapuru River Sustainable Development Reserve	Brazil	−00.579°	−052.628°	*H. mondolfii*	New record
Amapá, Serra do Navio, Cancão Municipal Natural Park	Brazil	00.900°	−052.013°	*H. mondolfii*	New record
Acre, Feijó, Jurupari River	Brazil	−08.150°	−070.350°	*H. mondolfii*	Venâncio et al. (2014)
Amazonas, Japurá, Ecological Station Juami-Japurá	Brazil	−01.756°	−067.613°	*H. mondolfii*	speciesLink (2020)
Pará, Altamira	Brazil	−02.971°	−052.277°	*H. mondolfii*	Oliveira et al. (2015b)
Pará, Óbidos, Ecological Station Grão-Pará Centre	Brazil	00.630°	−055.728°	*H. mondolfii*	Ávila-Pires et al. (2010)
Pará, Vitória do Xingu	Brazil	−02.880°	−052.010°	*H. mondolfii*	speciesLink (2020)
Pando, Settlement San Antonio	Bolivia	−11.483°	−068.866°	*H. mondolfii*	Castroviejo-Fisher et al. (2011b)
Amazonas, Leticia	Colombia	−04.003°	−069.895°	*H. mondolfii*	Castroviejo-Fisher et al. (2011a)
Crique Gabrielle	French Guiana	04.683°	−052.300°	*H. mondolfii*	Castroviejo-Fisher et al. (2011a)
Iwokrama Forest, Field Station	Guyana	04.671°	−058.685°	*H. mondolfii*	Castroviejo-Fisher et al. (2011a)
Iwokrama Forest, Turtle mountain	Guyana	04.730°	−058.724°	*H. mondolfii*	Castroviejo-Fisher et al. (2011a)
Madre de Dios, Tambopata Province	Peru	−12.070°	−069.493°	*H. mondolfii*	Chávez et al. (2019)
Maynas, San Juan	Peru	−03.952°	−073.432°	*H. mondolfii*	speciesLink (2020)
Marowijne	Suriname	05.391°	−054.260°	*H. mondolfii*	Castroviejo-Fisher et al. (2011a)
Delta Amaruco, Caño Jotajama,	Venezuela	09.333°	−061.500°	*H. mondolfii*	Señaris and Ayarzagüena (2001)
Delta Amaruco, Serranía de Imataca	Venezuela	08.366°	−061.533°	*H. mondolfii*	Señaris and Ayarzagüena (2001)
Mabura Hill Forest Reserve	Guyana	05.155°	−058.699°	*	Castroviejo-Fisher et al. (2011a)
Sipaliwini	Suriname	02.026°	−056.125°	*	Fouquet et al. (2015)

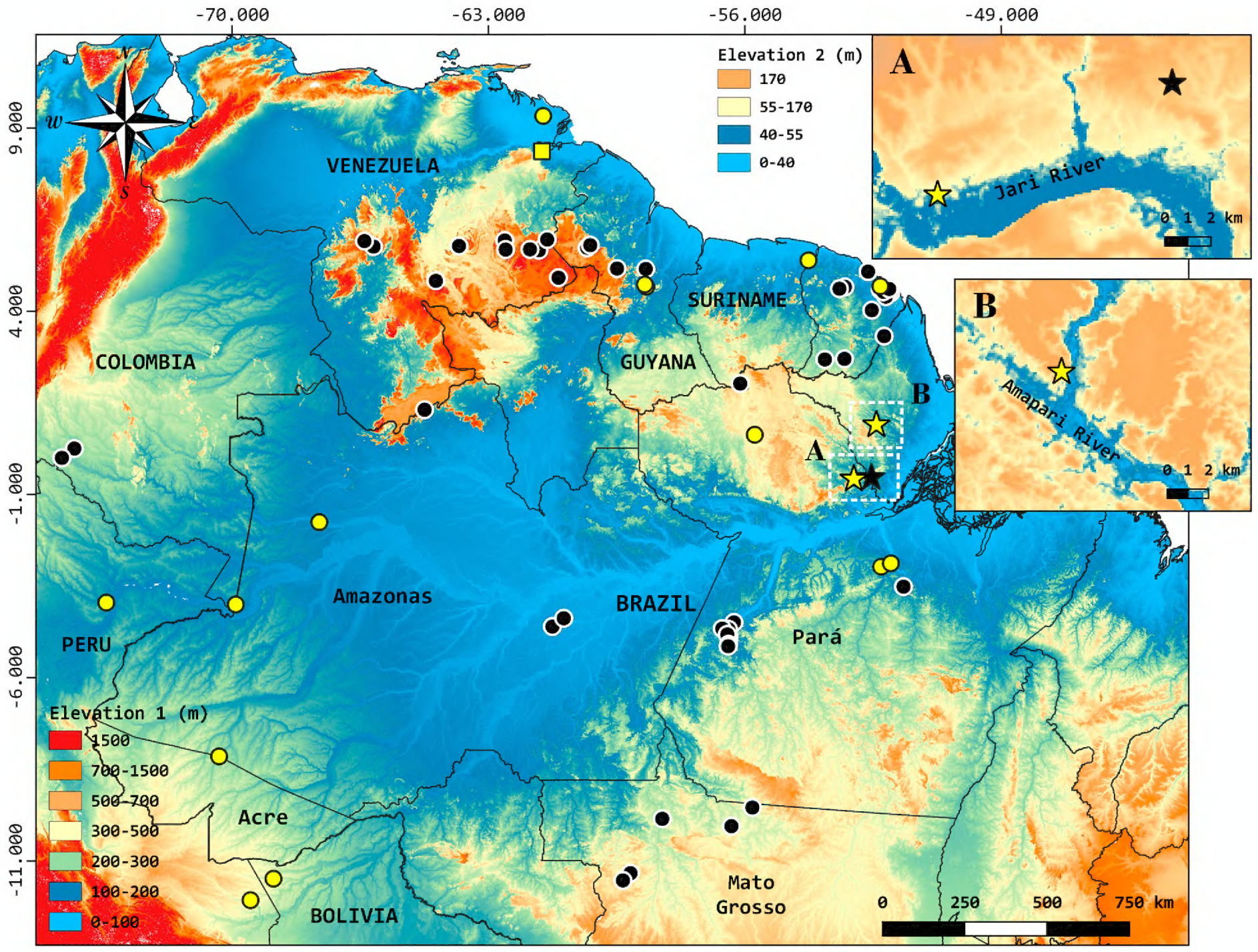

Figure 2. Map of northern South America with known localities of *Hyalinobatrachium cappellei* (black) and *H. mondolfii* (yellow). The previously known records are indicated by circles, the new records in the state of Amapá are indicated by stars, and the type locality of *H. mondolfii* is indicated by a yellow square. The type locality of *H. cappellei* (Saramacca River, Suriname) is not shown due to lack of precise coordinates (see Castroviejo-Fisher et al. 2011a).

life with faded yellow spots on a light green background covered with melanophores, iris golden with dark melanophores, and coloration in life of palm of hand and sole of foot white (Castroviejo-Fisher et al. 2011a). In *H. iaspidiense*, the dorsal coloration in life is light green with darker green patches and black dots, and iris yellow with dark gray flecks (Castroviejo-Fisher et al. 2011a).

***Hyalinobatrachium mondolfii* Señaris & Ayarzagüena, 2001**

Figure 1B–D

New records. BRAZIL • 1 adult ♂, SVL = 22.0 mm; state of Amapá, municipality of Serra do Navio, Cancão Municipal Natural Park; 00.900°N, 052.013°W; 99 m a.s.l.; 12 March 2018; Marcos R. Dias Souza leg.; found at night (20:02 h) perched on the underside of leaves hanging over the border of Amapari River (Fig. 1B–C); CECC 1813. • 1 adult ♂, SVL = 22.9 mm; state of Amapá, municipality of Laranjal do Jari, Iratapuru River Sustainable Development Reserve; 00.579°S, 052.628°W; 58 m a.s.l.; 17 January 2019; Rodrigo T. Pinheiro leg.; found at night (22:00 h) on a leaf of a bush at the edge of a water body, next to its clutch, 3 m above the ground; CECC 2783.

Identification. *Hyalinobatrachium mondolfii* can be easily differentiated from other Amazonian *Hyalinobatrachium* species by its snout rounded in dorsal and lateral views, tympanic membrane not visible in life, dorsal color in life green with yellow dots and minute melanophores, discs of fingers and toes yellowish, and color of iris reticulated by dark spots (Señaris and Ayarzagüena 2001; Castroviejo-Fisher et al. 2011a; Oliveira and Hernández-Ruz 2017). Morphological traits of *H. mondolfii* are sufficient to differentiate them from similar species such as *H. kawense* Castroviejo-Fisher, Vilà, Ayarzagüena, Blanc & Ernst, 2011 (white fingers and toes) and *H. yaku* Guayasamin, Cisneros-Heredia, Maynard, Lynch, Culebras & Hamilton, 2017 (dark green spots on dorsum and a completely exposed heart).

Discussion

The new records represent the first report of two *Hyalinobatrachium* species in Amazonia of the Brazilian state of Amapá, filling gaps in the known geographic range of *H. mondolfii* by extending its distribution 264 km east from the nearest previously known record (Óbidos, state of Pará; 00.630°N, 055.728°W; see Ávila-Pires

et al. 2010). It also represents the seventh record of this species in Brazil. The geographic distribution of *H. cappellei* is extended 344 km north from the nearest previous record (Altamira, state of Pará; 02.971°S, 052.277°W; see Oliveira et al. 2015a). We found both specimens nearby or over egg-clutches, which agrees with previous reports for glass frog species (Castroviejo-Fisher et al. 2011a). Our findings fill the previous geographic distribution gap of glass frog species in eastern Amazonia, confirming *H. cappellei* and *H. mondolfii* as geographically widespread in Amazonia (Simões et al. 2012; Venâncio et al. 2014; Chávez et al. 2019). Although both species can be locally abundant and *H. cappellei* is the most abundant glass frog in the Guiana Shield (Castroviejo-Fisher et al. 2011a), we only found two specimens of these species in each locality. We suggest that the low number of specimens reported in this study might reflect the low sampling effort in each locality and that, due to the fact that the specimens were found associated with egg-clutches, these species are likely more abundant than observed in this study.

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Authors' Contributions

VAMBF, RTP, APF, MRDS, and CECC conducted the fieldwork, wrote and revised the manuscript. VAMBF and CECC made the map and took the photographs. All authors have read and approved the submitted manuscript.

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